

SUBSOCIALITY IN DUNG BEETLES *COPRIS REPERTUS* WALKER AND *COPRIS INDICUS* GILL. (COLEOPTERA: SCARABAEIDAE)¹

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(With one plate)

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Nesting behaviour of *Copris repertus* and *C. indicus* were studied in the laboratory. Male-female cooperation and parental care were observed in both the species. Earthworms belonging to *Dichogaster* sp. were found to feed on the dung in the brood balls. Some atypical behaviour, like extension of brood chamber, etc. was observed in *C. repertus*. Biology of *Copris repertus* was also studied in the laboratory.

INTRODUCTION

Subsociality has been found in some genera of Scarabaeinae of which *Copris* is one. Nesting behaviour of several species of *Copris* have been studied in detail (Fabre, 1897; Halffter and Matthews, 1966; Rommel, 1961, Paik, 1976; Halffter and Edmonds, 1982; Klemperer, 1982a, 1982b). Arrow (1931) has reported 34 species of *Copris* in India. So far, the behaviour of none of these has been studied. An attempt has been made to study two commonly occurring species of *Copris*, *C. repertus* and *C. indicus*, which have variations in their nesting patterns.

MATERIAL AND METHODS

Adult beetles attracted to cow and sheep dung in pastures were collected and brought to the laboratory. They were separated sex-wise based on morphological characters.

To study the nesting structure, large cubic dealwood boxes of 0.9m sides were used. These

were filled with moist soil, on top of which fresh cowdung was dropped. The beetles were then released into this box. The box was covered with wooden planks. After about two weeks, one wall of the box was ripped open and the soil was sliced vertically with care, to study the nest architecture.

Nesting pattern and bisexual cooperation were studied in glass cages measuring 60 x 44 x 3 cm³). Glass walls were fixed 3 cm apart into a three sided wooden frame with grooves. Soil was filled into this cage and on top of this fresh cow dung was deposited. The beetles were then released into the cage, and the top of the cage covered with wire mesh to prevent the escape of beetles. Observations such as feeding, nest building and ball making, etc., were periodically taken.

RESULTS

***Copris repertus*:** The adults of *C. repertus* emerged during the month of May. This species was found to be attracted to both cow and elephant dung. After their emergence they fed initially within the dung pat and later made shallow food burrows. Using their clypeus and fore tibiae, an oblique tunnel was excavated. They scooped soil with the clypeus, brought it out

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carrying it above their head and threw it onto the surface. Later this tunnel was filled with dung which was brought from the surface. The beetle separated a little mass of dung from the dung pat on the ground surface and moved backwards into the tunnel with the rear end first. Then it turned and packed the dung into the tunnel. This food burrow was either single or branched, and was occupied by a single occupant, either a male or a female. The beetles fed on the stored dung for one or two days and later abandoned it in search of new dung pats. The old food burrows were found to contain left over dung and faecal matter. These food burrows were 5-6 cm deep. Apart from these burrows, a long horizontal tunnel about 2-3 cm was constructed beneath the soil surface, which measured 9 - 12 cm long and ended in a vertical drop of 20 - 40 cm. This was filled with dung in which the beetles were present. Most probably this was used for breeding.

When newly emerged beetles were introduced into cages with soil and dung, they entered the soil immediately after feigning death for a minute or two. They made food burrows and fed on the dung. Later they were not seen to engage in brood construction even though there was enough dung. But when the same beetles were removed and put afresh into rearing cages with soil and fresh dung they started constructing brood chambers.

Those beetles which were released in cages (with soil+no dung) immediately entered the soil. When fresh dung was dropped later into these cages the beetles did not come up for feeding on the dung, but made individual cells and remained inactive. Even after a lapse of two months, these beetles were found alive in the same condition.

After the feeding period (10-15 days) they started constructing brood chambers at an average depth of 17.53 (10-30) cm. The brood burrow consisted of a tunnel of diameter 1.73 (1.5-2.2) cm which ended in a wider brood chamber. The female worked in the lower

portions of the brood burrow, while the male restricted himself to the upper portion. During the process of digging the tunnel, the female scooped the soil, lifted it over her head and carried it half way along towards the burrow of the tunnel from where the male would take the soil from her and throw it onto the surface. The average amount of soil excavated was 172.53 (84.4-237) g.

Later, once a brood chamber had been constructed at the base of the tunnel, the male and the female commenced filling it with dung. The average dimensions of the brood chamber were 8.08 x 9.16 x 9.29 cm³.

The male, working on the surface, separated a fragment of dung using his clypeus and forelegs and brought it to the female who waited near the entrance of the tunnel. She received it from him with her forelegs and moved down the tunnel rear end first, till her abdomen touched the wall of the chamber. Then she climbed over the fragment, took a 180° turn, and packed the dung against the wall of the chamber using her clypeus and forelegs. In a similar manner, the entire chamber was packed with dung. To collect dung of volume 1.0 x 8.9 x 1.8 cm³ they took 20 minutes. During the entire process, whenever the male refused to do his share of work, the female coaxed him by butting him with her clypeus, after which he resumed the work. In one instance, when the male never returned after he went to bring the dung, the female waited for some time and then went up to find him resting near the entrance. She butted him so fiercely that he fell directly into the brood chamber after which he scurried back to the surface to resume his work of bringing dung.

After filling the chamber with dung (Fig. 1) the female excavated soil around the dung mass and made it a free mass of dung. This soil was partly thrown on to the surface and partly used for closing the tunnel; by doing so the female excluded the male, which was found in a small cell near the tunnel from then onwards.

Later, the female kneaded the accumulated mass of dung into a smooth, big mass, in which she laid several eggs. A small protuberance in the dung mass indicated the presence of eggs (Fig. 2). She separated a mass of dung along with an egg and made a brood ball. All the brood balls were similarly constructed. The mean number of eggs laid per female was 6 (3-9). The brood balls were spheroids (Figs. 3 & 4) The average diameter and weight of the brood ball was 3.77 ± 0.62 cm and 21.92 ± 11.45 g, $n = 25$, respectively. During the initial stages, these brood balls were devoid of a soil coating around them. Later, a thin layer of soil was applied by the mother onto each one of them. The mother kept constantly moving the balls and changing their position, which prevented the growth of the fungus on them. The mother guarded the brood against predators till the young ones emerged.

In those cages where more than one pair of beetles was released, only one pair constructed a brood chamber, while the others made food burrows and remained in them for the rest of the time.

When the brood balls were interchanged, the mother beetles showed no inhibiting behaviour, but accepted and took care of them. In another instance, two mother beetles were found in a single nest in which six brood balls and 236 g of dung mass were present.

In yet another case, a female had made a brood chamber which contained six brood balls and had extended the chamber into another small chamber in which two more brood balls were present.

Moisture played a crucial role in larval development, because many brood balls which were kept open had shrunken and shrivelled larvae which finally died. As the moisture percentage in the dung decreased it became progressively less palatable for the larva.

Twenty five pairs of beetles which were released in cement pots of dimensions 30 x 45 x

45 cm³ produced smaller brood balls of average diameter and weight 2.67 ± 0.22 cm, and 10.73 ± 46 g, $n = 22$ respectively, as compared to the average diameter (3.77 cm) and weight (21.92 g) of normal brood balls formed in deal wood boxes of dimensions 0.9 x 0.9 x 0.9 m³. Two eggs were laid in one of the smaller brood balls.

In ten cases, the entire brood was destroyed by earthworms *Dichogaster* sp. (Oligochaeta: Megascolecidae: Octochaetinae). In place of the brood, a mixture of dung, soil and excreta of earthworms was present. The mother beetles were found 10-12 cm away from the destroyed brood. Ten broods had larvae along with 2-3 earthworms present in the same ball.

The adults of *C. repertus* stridulated, making screeching noises by the in and out movements of their abdomen. During this process a sort of creamish white liquid oozed out of the anal opening. The larva produced a scratching noise, when the brood balls were touched. When such brood balls were opened it was seen that the scratching noise was the result of the scraping of the inner wall of the brood ball with the larval mandibles.

The brood balls had an egg chamber on top, with the egg glued to one end. The egg was elongate and creamy white. There was a fibrous network on the top of the egg chamber. The larvae lacked the noticeable projection or the hump, unlike the larvae of *Onthophagus* sp. (Fig. 5).

The third instar larva constructed its cocoon using its own excreta. The larva became pale and had an emptied gut by the time it completed cocoon construction. The pupa was creamy yellow initially, turning golden brown with advance in time.

Newly formed adults were chestnut red and stayed in the brood ball for 4-5 days. It took about 8-10 days for the complete melanization of the adults. The adults emerged by cutting a hole in the brood ball (Fig. 6) and then entered the soil.

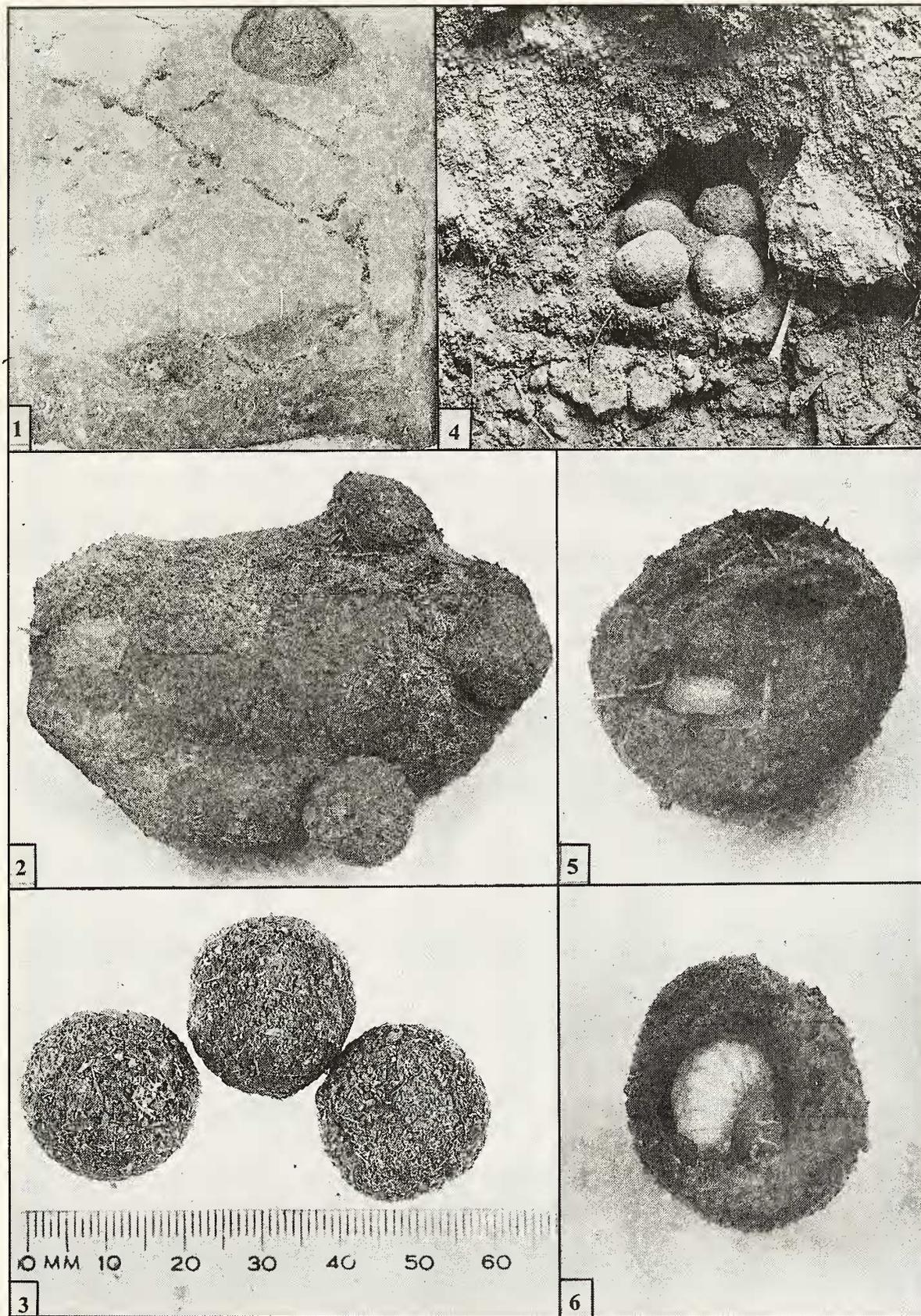


Fig. 1-6. *Copris repertus* Walker

1. Free mass of dung collected by the female for the brood chamber;
2. Small protuberances on the dung mass indicating the presence of the eggs;
3. Brood balls;
4. Nest with brood balls.
5. Second instar larva in the brood ball;
6. Emergence hole made by the newly formed adult in the brood ball.

The number of days taken for completing the different life stages is presented in Table 1 and the measurements of different life stages in Table 2.

TABLE 1
NUMBER OF DAYS TAKEN FOR EACH LIFE STAGE
OF *C. REPERTUS*

Egg	N	Min.	Max.	Ave.	S.D.
Egg	6	7	10	8.83	1.16
Total larval period	6	39	42	40.5	1.22
Pupa	9	24	29	26.77	1.56
Total life cycle	6	70	81	77	1.53

TABLE 2
DIMENSIONS OF DIFFERENT LIFE STAGES OF
COPRIS REPERTUS (IN MM.)

		N	Min.	Max.	Ave.	S.D.
Egg stage I	L	11	6.0	7.0	6.7	0.2
	B	10	3.0	4.0	3.4	0.4
Egg stage II	L	10	6.5	8.0	7.0	0.4
	B	10	4.0	5.0	4.5	0.3
Larva I instar		8	15.5	22.5	19.5	2.4
Larva II instar		12	29.0	40.0	32.8	3.2
Larva III instar		20	38	49.0	44.0	2.7
Pupa	L	20	16	23.0	19.9	1.7
	B	20	10.0	15.0	12.5	1.2

The mother beetle was found always moving over the brood balls, taking care of them. In all cases, whenever the brood balls were stacked in two tiers, she immediately made more place near the lower layer, and placed all balls in a single layer so that she could tend each one of them.

The mother beetles were found to break the brood balls into small fragments if the larva inside the particular brood ball was dead, whereas she repaired those brood balls (when they were broken) if they contained a live larva.

Some atypical behaviour exhibited by these beetles is mentioned below:

When an extra mass of dung was provided to a mother beetle, she used it to make more brood balls.

In one instance, when two pairs of beetles were released in a single cage, both the females prepared brood balls together in a single chamber; and finally one female chased away the other female and tended all the brood balls by herself. The other female stayed in a cell 2 cm away from the brood chamber.

In three cases, the mother beetles tended the brood balls for five days, after which they extended the brood chamber by further digging about 8 cm away and made a separate chamber and shifted all the brood balls into it and tended them.

Copris indicus: These beetles were attracted mainly to sheep dung, even though they were occasionally collected in cow and elephant dung.

C. indicus' behaviour is very similar to that of *C. repertus* but for a few aspects.

Adult beetles emerged during the month of June. They made shallow food burrows (7-8 cm) and fed on the dung they buried. By the end of June to beginning of July they started constructing burrows. Construction of the brood burrow involved both the male and the female.

The pattern of construction of the brood burrows varied from that of *C. repertus*.

In the laboratory, when the beetles were provided with sheep pellets, they behaved in the following manner. The female in cooperation with the male initially dug an oblique tunnel, which was very similar to that of the food burrow. The male carried the individual sheep pellets with his forelegs and walked to the entrance of the tunnel. Then he handed over the pellet to the waiting female who carried it into the tunnel. Similarly, they packed the tunnel with sheep pellets. Next, the female came out and dug a similar oblique tunnel adjacent to the first one, and the male and female filled this new tunnel also with sheep pellets. On an average, a pair of beetles carried 21 (14.1 g) sheep pellets ($n = 14$). After this, the female dug around the packed mass of dung, and made a chamber with dung in